

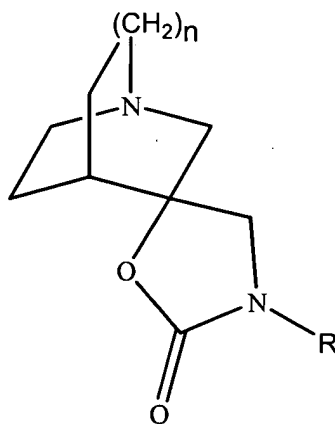
## CLAIMS

What is claimed is:

1. A method of treating a patient suffering from a condition mediated by release of  
5 a proinflammatory cytokine comprising  
treating said patient with a cholinergic agonist selective for an  $\alpha 7$   
nicotinic receptor in an amount sufficient to decrease the amount of the  
proinflammatory cytokine that is released from a macrophage  
wherein said condition is selected from the group consisting of  
10 appendicitis, peptic, gastric and duodenal ulcers, peritonitis, pancreatitis,  
epiglottitis, achalasia, cholangitis, cholecystitis, hepatitis, Whipple's disease,  
asthma, allergy, anaphylactic shock, immune complex disease, organ ischemia,  
reperfusion injury, organ necrosis, hay fever, sepsis, septicemia, endotoxic  
shock, cachexia, hyperpyrexia, eosinophilic granuloma, granulomatosis,  
15 sarcoidosis, septic abortion, epididymitis, vaginitis, prostatitis, urethritis,  
bronchitis, emphysema, rhinitis, cystic fibrosis, pneumonitis,  
pneumoultramicroscopic silicovolcanoconiosis, alveolitis, bronchiolitis,  
pharyngitis, pleurisy, sinusitis, influenza, respiratory syncytial virus infection,  
herpes infection, HIV infection, hepatitis B virus infection, hepatitis C virus  
20 infection, disseminated bacteremia, Dengue fever, candidiasis, malaria,  
filariasis, amebiasis, hydatid cysts, burns, vasculitis, angiitis, endocarditis,  
arteritis, atherosclerosis, thrombophlebitis, pericarditis, myocarditis, myocardial  
ischemia, periarteritis nodosa, rheumatic fever, coeliac disease, congestive heart  
failure, adult respiratory distress syndrome, chronic obstructive pulmonary  
25 disease, meningitis, encephalitis, neuritis, neuralgia, spinal cord injury,  
paralysis, uveitis, arthritides, arthralgias, osteomyelitis, fasciitis, Paget's disease,  
gout, periodontal disease, rheumatoid arthritis, synovitis, myasthenia gravis,  
thyroiditis, systemic lupus erythematosus, Goodpasture's syndrome, Behcets's  
syndrome, allograft rejection, graft-versus-host disease, ankylosing spondylitis,

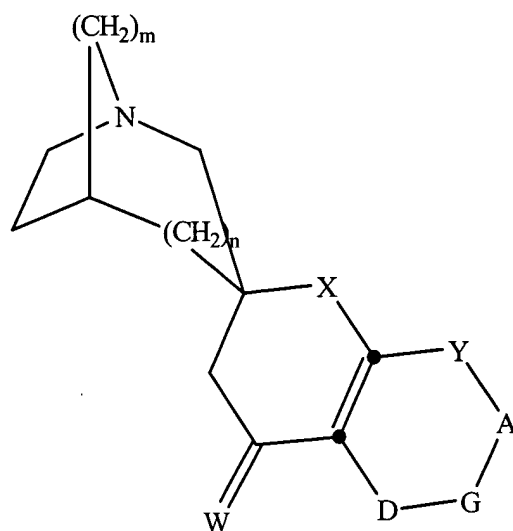
Berger's disease, ankylosing spondylitis, Berger's disease, Retier's syndrome, and Hodgkins disease.

2. The method of claim 1, wherein the proinflammatory cytokine is selected from the group consisting of tumor necrosis factor (TNF), interleukin (IL)-1 $\beta$ , IL-6, IL-18 and HMG-1.
3. The method of claim 1, wherein the proinflammatory cytokine is TNF.
4. The method of claim 1, wherein the cholinergic agonist is selected from the group consisting of a quaternary analog of cocaine; (1-aza-bicyclo[2.2.2]oct-3-yl)-carbamic acid 1-(2-fluorophenyl)-ethyl ester; a compound of formula I:



I

- wherein, R represents hydrogen or methyl, and n represents 0 or 1; a pharmaceutically acceptable salt of a compound of formula I; a compound of formula II:



II

wherein:

m is 1 or 2,

n is 0 or 1,

Y is CH, N or NO,

5 X is oxygen or sulfur,

W is oxygen, H<sub>2</sub> or F<sub>2</sub>,

A is N or C(R<sup>2</sup>),

G is N or C(R<sup>3</sup>),

D is N or C(R<sup>4</sup>),

10 with the proviso that no more than one of A, G and D is nitrogen but at least one of Y, A, G and D is nitrogen or NO,

R<sup>1</sup> is hydrogen or C<sub>1</sub>-C<sub>4</sub> alkyl,

R<sup>2</sup>, R<sup>3</sup> and R<sup>4</sup> are independently hydrogen, halogen, C<sub>1</sub>-C<sub>4</sub> alkyl, C<sub>2</sub>-C<sub>4</sub> alkenyl,

C<sub>2</sub>-C<sub>4</sub> alkynyl, aryl, heteroaryl, OH, OC<sub>1</sub>-C<sub>4</sub> alkyl, CO<sub>2</sub>R<sub>1</sub>, -CN, -NO<sub>2</sub>, -NR<sub>5</sub>R<sub>6</sub>, -

15 CF<sub>3</sub> or -OSO<sub>2</sub>CF<sub>3</sub>, or R<sup>2</sup> and R<sup>3</sup>, R<sup>3</sup> and R<sup>4</sup>, respectively, may together form another six membered aromatic or heteroaromatic ring sharing A and G, or G and D, respectively, containing between zero and two nitrogen atoms, and substituted with one to two of the following substituents: independently

hydrogen, halogen, C<sub>1</sub>-C<sub>4</sub> alkyl, C<sub>2</sub>-C<sub>4</sub> alkenyl, C<sub>2</sub>-C<sub>4</sub> alkynyl, aryl, heteroaryl,  
OH, OC<sub>1</sub>-C<sub>4</sub> alkyl, CO<sub>2</sub>R<sup>1</sup>, -CN, -NO<sub>2</sub>, -NR<sup>5</sup>R<sup>6</sup>, -CF<sub>3</sub> or -OSO<sub>2</sub>CF<sub>3</sub>,

R<sup>5</sup> and R<sup>6</sup> are independently hydrogen, C<sub>1</sub>-C<sub>4</sub> alkyl, C(O)R<sup>7</sup>, C(O)NHR<sup>8</sup>,  
C(O)OR<sup>9</sup>, SO<sub>2</sub>R<sup>10</sup> or may together be (CH<sub>2</sub>)<sub>j</sub>Q(CH<sub>2</sub>)<sub>k</sub> where Q is O, S, NR<sup>11</sup>,

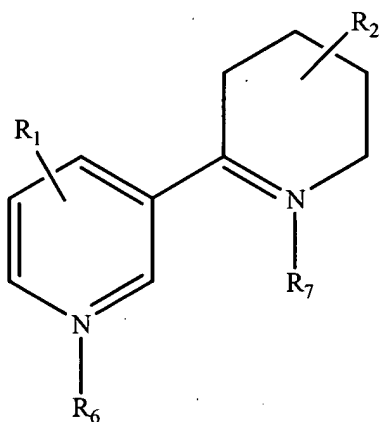
or a bond,

j is 2 to 7,

k is 0 to 2,

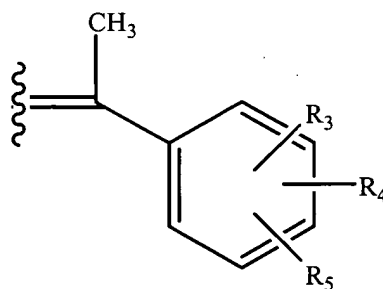
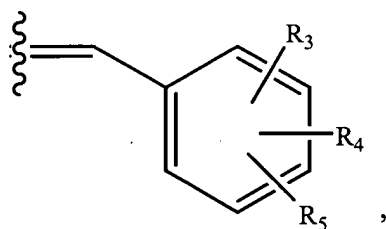
R<sup>7</sup>, R<sup>8</sup>, R<sup>9</sup>, R<sup>10</sup> and R<sup>11</sup> are independently C<sub>1</sub>-C<sub>4</sub> alkyl, aryl, or heteroaryl, or  
an enantiomer thereof; a pharmaceutically acceptable salt of a compound of

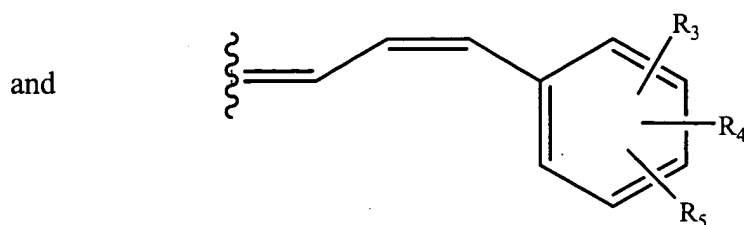
formula II; a compound of formula III:



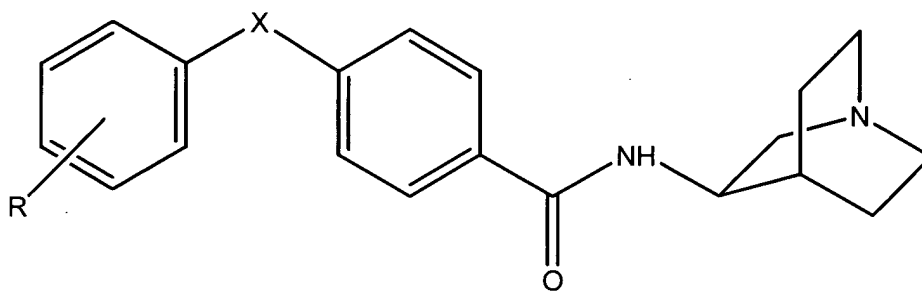
III

wherein R<sub>1</sub>, R<sub>6</sub> and R<sub>7</sub> are hydrogen or C<sub>1</sub>-C<sub>4</sub> alkyl, and R<sub>2</sub> is selected from a  
group of





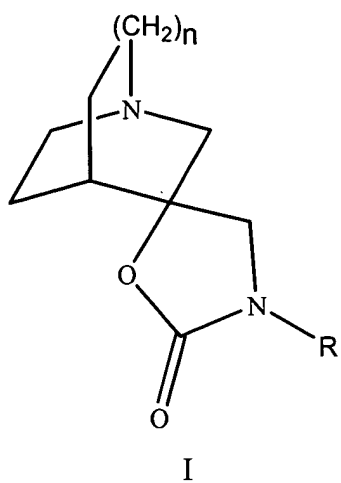
wherein,  $R_3$ ,  $R_4$  and  $R_5$  are selected from the group consisting of hydrogen,  $C_1$ - $C_4$  alkyl optionally substituted with N,N-dialkylamino having 1 to 4 carbons in each of the alkyls,  $C_1$ - $C_6$  alkoxy optionally substituted with N,N-dialkylamino having 1 to 4 carbons in each of the alkyls, carboalkoxy having 1 to 4 carbons in the alkoxy, amino, amido having 1 to 4 carbons in the acyl, cyano, and N,N-dialkylamino having 1 to 4 carbons in each of the alkyls, halo, hydroxyl or nitro; and a compound of formula IV:



IV

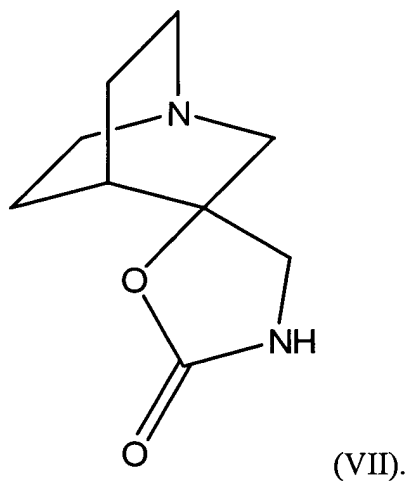
wherein X is O or S, and R is selected from the group consisting of H,  $OR_1$ ,  $NHC(O)R_1$ , and a halogen, wherein  $R_1$  is a  $C_1$ - $C_4$  alkyl.

5. The method of claim 1, wherein the cholinergic agonist is a compound of formula I:

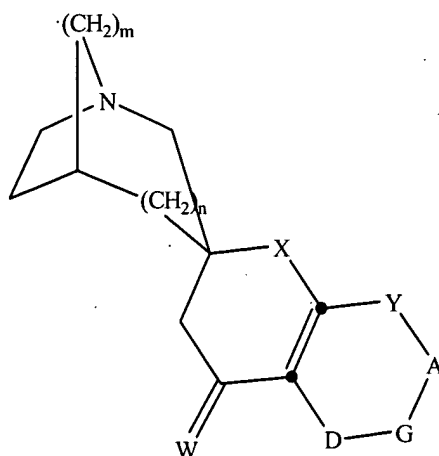


wherein, R represents hydrogen or methyl, and  
 n represents 0 or 1;  
 or a pharmaceutically acceptable salt thereof.

- 5    6.    The method of claim 5, wherein the cholinergic agonist is (-)-spiro[1-azabicyclo[2.2.2]octane-3,5'-oxazolidin-2'-one]



7.    The method of claim 1, wherein the cholinergic agonist is a compound of formula II:



II

wherein:

m is 1 or 2;

n is 0 or 1;

Y is CH, N or NO;

5 X is oxygen or sulfur;

W is oxygen, H<sub>2</sub> or F<sub>2</sub>;

A is N or C(R<sup>2</sup>);

G is N or C(R<sup>3</sup>);

D is N or C(R<sup>4</sup>);

10 with the proviso that no more than one of A, G and D is nitrogen but at least one of Y, A, G and D is nitrogen or NO;

R<sup>1</sup> is hydrogen or C<sub>1</sub>-C<sub>4</sub> alkyl;

15 R<sup>2</sup>, R<sup>3</sup> and R<sup>4</sup> are independently hydrogen, halogen, C<sub>1</sub>-C<sub>4</sub> alkyl, C<sub>2</sub>-C<sub>4</sub> alkenyl, C<sub>2</sub>-C<sub>4</sub> alkynyl, aryl, heteroaryl, OH, OC<sub>1</sub>-C<sub>4</sub> alkyl, CO<sub>2</sub>R<sub>1</sub>, -CN, -NO<sub>2</sub>, -NR<sub>5</sub>R<sub>6</sub>, -CF<sub>3</sub> or -OSO<sub>2</sub>CF<sub>3</sub>, or R<sup>2</sup> and R<sup>3</sup>, R<sup>3</sup> and R<sup>4</sup>, respectively, may together form another six membered aromatic or heteroaromatic ring sharing A and G, or G and D, respectively, containing between zero and two nitrogen atoms, and substituted with one to two of the following substituents: independently

hydrogen, halogen, C<sub>1</sub>-C<sub>4</sub> alkyl, C<sub>2</sub>-C<sub>4</sub> alkenyl, C<sub>2</sub>-C<sub>4</sub> alkynyl, aryl, heteroaryl, OH, OC<sub>1</sub>-C<sub>4</sub> alkyl, CO<sub>2</sub>R<sup>1</sup>, -CN, -NO<sub>2</sub>, -NR<sup>5</sup>R<sup>6</sup>, -CF<sub>3</sub> or -OSO<sub>2</sub>CF<sub>3</sub>;

R<sup>5</sup> and R<sup>6</sup> are independently hydrogen, C<sub>1</sub>-C<sub>4</sub> alkyl, C(O)R<sup>7</sup>, C(O)NHR<sup>8</sup>, C(O)OR<sup>9</sup>, SO<sub>2</sub>R<sup>10</sup> or may together be (CH<sub>2</sub>)<sub>j</sub>Q(CH<sub>2</sub>)<sub>k</sub> where Q is O, S, NR<sup>11</sup>,  
 5 or a bond;

j is 2 to 7;

k is 0 to 2;

R<sup>7</sup>, R<sup>8</sup>, R<sup>9</sup>, R<sup>10</sup> and R<sup>11</sup> are independently C<sub>1</sub>-C<sub>4</sub> alkyl, aryl, or heteroaryl,  
 or an enantiomer thereof,

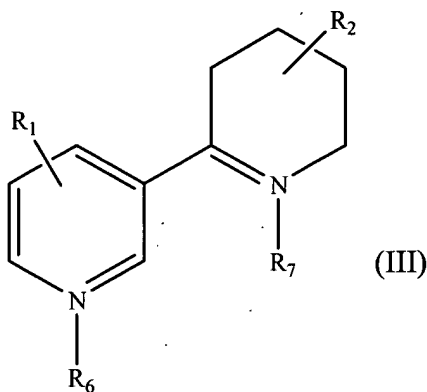
10 or a pharmaceutically acceptable salts thereof.

8. The method of claim 7, wherein the cholinergic agonist is a compound of formula II wherein m is 1; n is 0; p is 0; x is oxygen; A is C(R<sup>2</sup>); G is C(R<sup>3</sup>); and D is C(R<sup>4</sup>).

15

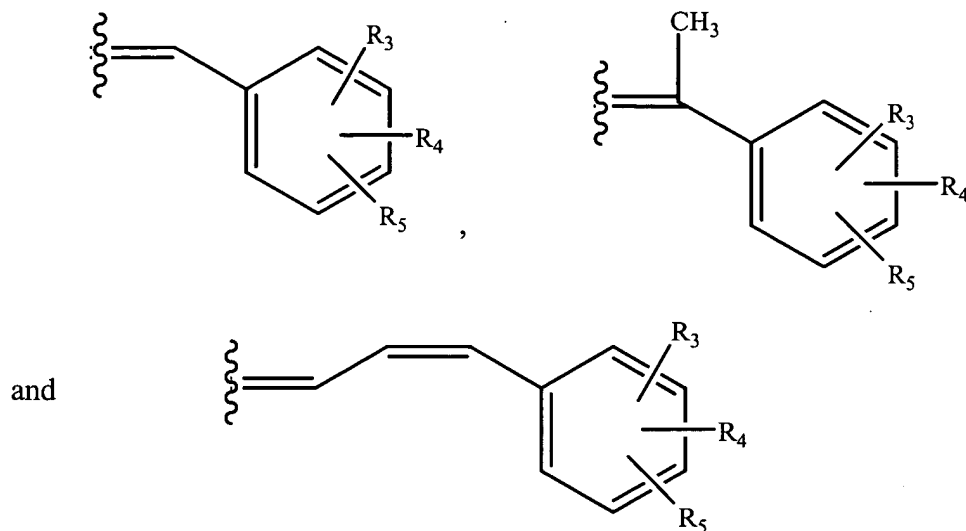
9. The method of claim 7, wherein the cholinergic agonist is 5'-phenylspiro[1-azabicyclo[2.2.2]octane-3,2'-(3'H)-furo[2,3-b]pyridin].

10. The method of claim 1, wherein the cholinergic agonist is a compound of  
 20 formula III:





wherein  $R_1$ ,  $R_6$  and  $R_7$  are hydrogen or  $C_1$ - $C_4$  alkyl; and  $R_2$  is selected from a group of



wherein,  $R_3$ ,  $R_4$  and  $R_5$  are selected from the group consisting of hydrogen,  $C_1$ - $C_4$  alkyl optionally substituted with N,N-dialkylamino having 1 to 4 carbons in each of the alkyls,  $C_1$ - $C_6$  alkoxy optionally substituted with N,N-dialkylamino having 1 to 4 carbons in each of the alkyls, carboalkoxy having 1 to 4 carbons in the alkoxy, amino, amido having 1 to 4 carbons in the acyl, cyano, and N,N-dialkylamino having 1 to 4 carbons in each of the alkyls, halo, hydroxyl or nitro.

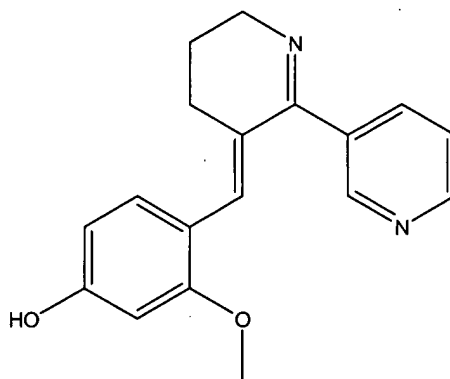
- 10 11. The method of claim 10, wherein the cholinergic agonist is a compound of formula III, wherein  $R_2$  is attached to the 3-position of the tetrahydropyridine ring, and further wherein  $R_3$ , which is attached to the 4- or the 2- position of the phenyl ring, is selected from the group consisting of amino, hydroxyl, chloro, cyano, dimethylamino, methyl, methoxy, acetylamino, acetoxo, and nitro.

15

12. The method of claim 10, wherein the cholinergic agonist is a compound selected from the group consisting of formula III, wherein  $R_3$  is hydroxyl, and wherein  $R_1$ ,  $R_4$ , and  $R_5$  are hydrogen; formula III, wherein  $R_3$  is acetylamino and wherein  $R_1$ ,  $R_4$ , and  $R_5$  are hydrogen; formula III, wherein  $R_3$  is acetoxo and wherein  $R_1$ ,

$R_4$ , and  $R_5$  are hydrogen; formula III, wherein  $R_3$  is methoxy, and wherein  $R_1$ ,  $R_4$ , and  $R_5$  are hydrogen; formula III, wherein  $R_3$  is methoxy and wherein  $R_1$  and  $R_4$  are hydrogen, and further wherein  $R_3$  is attached to the 2-position of the phenyl ring, and  $R_5$ , which is attached to the 4-position of the phenyl ring, is methoxy or hydroxy.

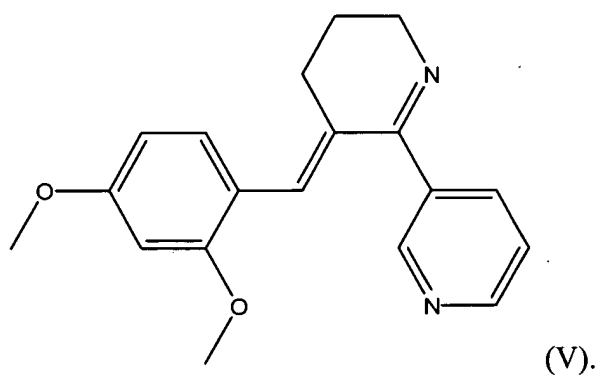
13. The method of claim 10, wherein the cholinergic agonist is selected from the group consisting of 3-2,4-dimethoxybenzylidene anabaseine (DMXB-A), 3-(4-hydroxybenzylidene)anabaseine, 3-(4-methoxybenzylidene)anabaseine, 3-(4-aminobenzylidene)anabaseine, 3-(4-hydroxy-2-methoxybenzylidene)anabaseine, 3-(4-methoxy-2-hydroxybenzylidene)anabaseine, trans-3-cinnamylidene anabaseine, trans-3-(2-methoxy-cinnamylidene)anabaseine and trans-3-(4-methoxycinnamylidene)anabaseine.
14. The method of claim 10, wherein the cholinergic agonist is 3-(4-hydroxy-2-methoxybenzylidene)anabaseine



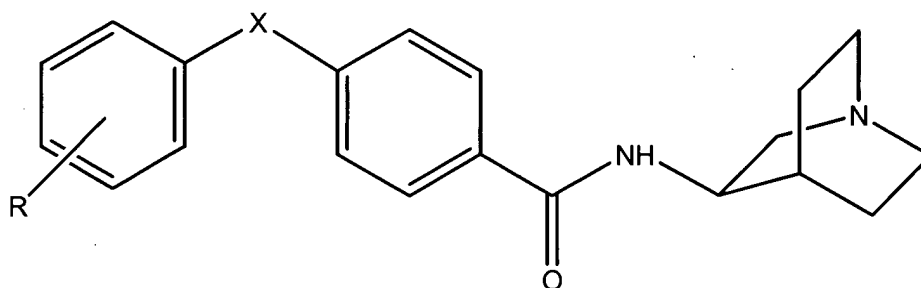
(VI).

15. The method of claim 10, wherein the cholinergic agonist is 3-(2,4-dimethoxybenzylidene)anabaseine.

- 61 -



16. The method of claim 1, wherein the cholinergic agonist is a compound of formula IV:



IV

wherein X is O or S; and

R is selected from the group consisting of H, OR<sub>1</sub>, NHC(O)R<sub>1</sub>, and a halogen, wherein R<sub>1</sub> is a C<sub>1</sub>-C<sub>4</sub> alkyl.

17. The method of claim 15, wherein the cholinergic agonist is selected from a group consisting of N-[(3R)-1-azabicyclo[2.2.2]oct-3-yl]-4-(4-hydroxyphenoxy)benzamide, N-[(3R)-1-azabicyclo[2.2.2]oct-3-yl]-4-(4-acetamidophenoxy)benzamide, N-[(3R)-1-azabicyclo[2.2.2]oct-3-yl]-4-(phenylsulfanyl)benzamide, and N-[(3R)-1-azabicyclo[2.2.2]oct-3-yl]-4-(3-chlorophenylsulphonyl)benzamide.

18. The method of claim 15, wherein the cholinergic agonist is N-[(3R)-1-azabicyclo[2.2.2]oct-3-yl]-4-(phenylsulfanyl)benzamide.
- 5 19. The method of claim 1, wherein the cholinergic agonist is cocaine methiodide.
20. The method of claim 1 wherein the condition is selected from the group consisting of appendicitis, peptic, gastric and duodenal ulcers, peritonitis, pancreatitis, hepatitis, asthma, allergy, anaphylactic shock, organ necrosis, hay  
10 fever, sepsis, septicemia, endotoxic shock, cachexia, septic abortion, disseminated bacteremia, burns, coeliac disease, congestive heart failure, adult respiratory distress syndrome, chronic obstructive pulmonary disease, rheumatoid arthritis, systemic lupus erythematosus, myocardial ischemia, spinal cord injury, paralysis, allograft rejection and graft-versus-host disease.
- 15 21. The method of claim 1 wherein the condition selected from the group consisting of appendicitis, peptic, gastric or duodenal ulcers, peritonitis, pancreatitis, hepatitis, asthma, allergy, anaphylactic shock, organ necrosis, hay fever, sepsis, septicemia, endotoxic shock, cachexia, septic abortion, disseminated bacteremia,  
20 burns, congestive heart failure, adult respiratory distress syndrome, chronic obstructive pulmonary disease, rheumatoid arthritis, systemic lupus erythematosus, myocardial ischemia, cerebral infarction, cerebral embolism, spinal cord injury, paralysis, allograft rejection or graft-versus-host disease.
- 25 22. The method of Claim 1 wherein the condition is selected from the group consisting of peritonitis, pancreatitis, sepsis, endotoxic shock, adult respiratory distress syndrome, chronic obstructive pulmonary disease, rheumatoid arthritis, systemic lupus erythematosus, myocardial ischemia, allograft rejection, asthma, graft-versus-host-disease, congestive heart failure and cystic fibrosis.
- 30

23. The method of claim 1, wherein the condition selected from the group consisting of peritonitis, pancreatitis, sepsis, endotoxic shock, cachexia, adult respiratory distress syndrome, chronic obstructive pulmonary disease, rheumatoid arthritis, systemic lupus erythematosus, myocardial ischemia, and allograft rejection.
- 5
24. The method of claim 1, wherein the condition is sepsis.
25. A method for determining whether a compound is a cholinergic agonist selective for an  $\alpha 7$  nicotinic receptor, the method comprising
- 10 determining whether the compound inhibits release of a proinflammatory cytokine from a mammalian cell, and
- determining whether the compound is a cholinergic agonist reactive with at least one nicotinic receptor that is not  $\alpha 7$ ,
- 15 wherein a compound that inhibits the release of the proinflammatory cytokine from the mammalian cell, but is not a cholinergic agonist reactive with at least one nicotinic receptor that is not  $\alpha 7$ , is a cholinergic agonist selective for an  $\alpha 7$  nicotinic receptor.
26. The method of claim 25, wherein the proinflammatory cytokine is selected from the group consisting of tumor necrosis factor (TNF), interleukin (IL)-1 $\beta$ , IL-6, IL-18 and HMG-1.
- 20
27. The method of claim 25 wherein the proinflammatory cytokine is TNF.
28. The method of claim 25 wherein the mammalian cell is an immune cell.
- 25
29. The method of claim 25 wherein the mammalian cell is a macrophage.
30. The method of claim 25 further comprising treating the mammalian cell with an agent that stimulates a proinflammatory cytokine cascade.
- 30

31. The method of claim 30, wherein the agent is LPS.
32. The method of claim 25 wherein the determination of inhibition of  
5 proinflammatory cytokine release comprises measurement of mRNA of the  
proinflammatory cytokine.
33. The method of claim 25 wherein the determination of inhibition of  
10 proinflammatory cytokine release comprises measurement of the  
proinflammatory cytokine protein.
34. The method of claim 25 wherein the determination of inhibition of  
proinflammatory cytokine release comprises measurement of proinflammatory  
cytokine activity.
- 15 35. A method for determining whether a compound is a cholinergic antagonist  
reactive with an  $\alpha 7$  nicotinic receptor, the method comprising determining  
whether the compound reduces the ability of a cholinergic agonist to inhibit the  
release of a proinflammatory cytokine from a mammalian cell,  
20 wherein a compound that reduces the ability of a cholinergic agonist to  
inhibit the release of a proinflammatory cytokine from a mammalian cell is a  
cholinergic antagonist reactive with an  $\alpha 7$  receptor.
- 25 36. The method of claim 35, wherein the proinflammatory cytokine is selected from  
the group consisting of tumor necrosis factor (TNF), interleukin (IL)-1 $\beta$ , IL-6,  
IL-18 and HMG-1.
37. The method of claim 35, wherein the proinflammatory cytokine is TNF.
- 30 38. The method of claim 35, wherein the mammalian cell is an immune cell.

39. The method of claim 35, wherein the mammalian cell is a macrophage.
40. The method of claim 35, further comprising treating the mammalian cell with an  
5 agent that stimulates a proinflammatory cytokine cascade.
41. The method of claim 40, wherein the agent is LPS.
42. The method of claim 35, wherein the determination of whether the compound  
10 reduces the ability of the cholinergic agonist to inhibit the release of a  
proinflammatory cytokine from a mammalian cell comprises measurement of  
mRNA of the proinflammatory cytokine.
43. The method of claim 35, wherein the determination of whether the compound  
15 restrains the ability of the cholinergic agonist to inhibit the release of a  
proinflammatory cytokine from a mammalian cell comprises measurement of  
the proinflammatory cytokine protein.
44. The method of claim 35, wherein the determination of whether the compound  
20 restrains the ability of the cholinergic agonist to inhibit the release of a  
proinflammatory cytokine from a mammalian cell comprises measurement of  
proinflammatory cytokine activity.
45. A method for determining whether a test compound has the ability to inhibit  
25 inflammation, the method comprising determining whether the test compound is  
a cholinergic agonist reactive with an  $\alpha 7$  nicotinic receptor.
46. The method of claim 45, wherein the receptor is on a macrophage.

47. A method for determining whether a test compound has the ability to inhibit inflammation, the method comprising determining whether the test compound inhibits binding of an antagonist to an  $\alpha 7$  nicotinic receptor.
- 5 48. The method of claim 47, wherein the antagonist to an  $\alpha 7$  receptor is bungarotoxin.
49. An oligonucleotide or mimetic capable of inhibiting attenuation of lipopolysaccharide-induced TNF release from a mammalian macrophage upon  
10 exposure of the macrophage to a cholinergic agonist, wherein the oligonucleotide or mimetic consists essentially of a sequence greater than 5 nucleotides long that is complementary to an mRNA of an  $\alpha 7$  receptor.
50. The oligonucleotide or mimetic of claim 49, wherein the sequence is  
15 complementary to a transcription initiation region of the mRNA.
51. The oligonucleotide of claim 49, wherein the sequence comprises 5'-gcagcgcattgtgagtcctcg-3'.
- 20 52. The oligonucleotide or mimetic of claim 49, wherein the sequence consists essentially of 5'-gcagcgcattgtgagtcctcg-3'.
53. A method of inhibiting attenuation of TNF release from a mammalian macrophage upon exposure of the macrophage to a cholinergic agonist, the  
25 method comprising treating the macrophage with the oligonucleotide or mimetic of claim 49.
54. The method of claim 53, wherein the macrophage is in a mammal.
- 30 55. The method of claim 54, wherein the mammal is a human.